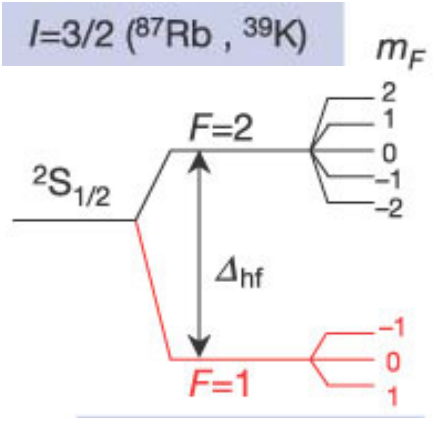
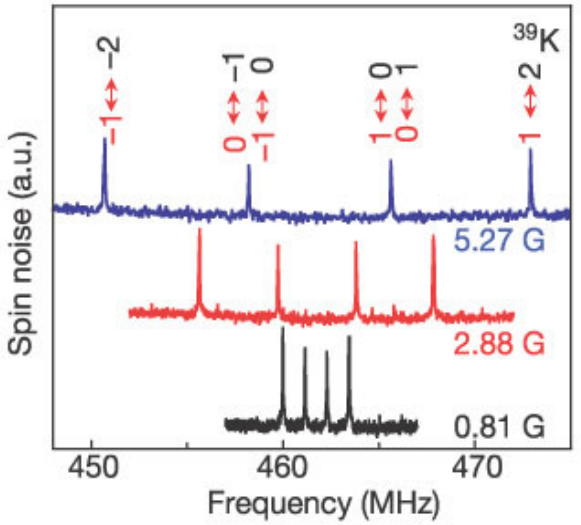
Spectroscopy of spontaneous spin noise as a probe of spin dynamics and magnetic resonance

Not all noise in experimental measurements is unwelcome. As devices shrink in size to the nanoscale regime, fewer atoms and magnetic spins dominate the device behavior and noise processes become more prominent. A recent collaboration among experimentalists at the National High Magnetic Field Laboratory and the theory department at Los Alamos National Laboratory established the usefulness of NOISE SPECTROSCOPY as a way to study the same magnetic energy levels that typically require the application of magnetic fields in nuclear magnetic resonance (NMR) experiments. In fact, because these noise measurements do not require a magnetic field to work, they provide a measurement of magnetic spin dynamics and magnetic resonance without perturbing the sample by an external magnetic field. By drawing on the fluctuation-dissipation theorem, a cornerstone of modern physics, this work firmly establishes that one scientist's noise is another scientist's signal! Noise spectroscopy should find applications as a new probe of ultra-small magnetic, electronic and biological systems.



The magnetic energy levels of rubidium (^{87}Rb) and potassium (^{39}K) which both have nuclear spin $I = 3/2$.

At right, spontaneous spin coherences in the noise spectrum of ^{39}K at magnetic fields of B=0.8, 2.9 and 5.3G.



Crooker, et al, Nature 431, 49-52 (02 Sep 2004)